

CLAIMS

What is claimed is:

1. A neutral black ink for ink-jet printing, comprising:
 - 5 an ink vehicle; carbon black (Ki), cyan pigment (Ci) and either violet or magenta pigment (V/Mi); wherein aKi Spectrum + bCi Spectrum + cV/Mi Spectrum = Neutral i Spectrum of absorptivity where a, b and c are weight percentages of Ki, Ci and V/Mi in Neutral i and a + b+ c = 100%, and where the total absorptivity of Ki, Ci, V/Mi, and Neutral i Spectra is expressed at between
 - 10 350 nm and 750 nm wavelength and the Neutral i Spectrum approximates a horizontal line on a graph having a horizontal axis showing wavelength and a vertical axis showing absorptivity.
2. A neutral black ink for ink-jet printing, comprising:
 - 15 an ink vehicle; carbon black, cyan pigment and violet pigment; wherein the absorbance ratio of carbon black: cyan pigment: violet pigment for black ink is 0.18:0.05:0.08 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25%;
 - 20 and wherein the carbon black, cyan pigment and violet pigment are associated with a polymer or polymers which render the carbon black, cyan pigment and violet pigment dispersible in aqueous solution.
3. The neutral black ink of claim 2 wherein the wavelength of the peak maxima for the cyan of the neutral black ink is 610 to 620 nm.
4. The neutral black ink of claim 2 wherein the wavelength of the peak maxima for the violet of the neutral black ink is 530 to 540 nm.
- 25
5. The neutral black ink of claim 2, wherein the polymer or polymers comprise acrylates.
6. The neutral black ink of claim 2, wherein the neutral black ink is printed together with a neutral medium gray ink, the neutral medium gray ink comprising:
 - 30 an ink vehicle; carbon black, cyan pigment and violet pigment; wherein the absorbance ratio of carbon black: cyan pigment: violet pigment for neutral medium gray ink is 0.04:0.01:0.02 with values being measured at 1/5K dilution,

at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25%.

7. The neutral black ink of claim 6 wherein the wavelength of the peak maxima for the cyan of the neutral medium gray ink is 610 to 620 nm.

5 8. The neutral black ink of claim 6 wherein the wavelength of the peak maxima for the violet of the neutral medium gray ink is 530 to 540 nm.

9. The neutral black ink of claim 2, wherein the neutral black ink is printed together with a neutral dark gray ink and a neutral light gray ink, the neutral dark gray ink comprising:

10 an ink vehicle; carbon black, cyan pigment and violet pigment; wherein the absorbance ratio of carbon black: cyan pigment: violet pigment for neutral dark gray ink is 0.06:0.02:0.03 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25%

15 and the neutral light gray ink comprising:

an ink vehicle; carbon black, cyan pigment and violet pigment; wherein the absorbance ratio of carbon black: cyan pigment: violet pigment for neutral light gray ink is 0.02:0.01:0.01 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25%.

20 10. The neutral black ink of claim 9 wherein the wavelength of the peak maxima for the cyan of the neutral dark gray ink is 610 to 620 nm.

11. The neutral black ink of claim 9 wherein the wavelength of the peak maxima for the violet of the neutral dark gray ink is 530 to 540 nm.

25 12. The neutral black ink of claim 9 wherein the wavelength of the peak maxima for the cyan of the neutral light gray ink is 610 to 620 nm.

13. The neutral black ink of claim 9 wherein the wavelength of the peak maxima for the violet of the neutral light gray ink is 530 to 540 nm.

30 14. The neutral black ink of claim 2, wherein the violet pigment is selected from the group consisting of PV19, PV42, PV23, PV3, PV19, PV23, PV32, PV36, and PV38.

15. The neutral black ink of claim 2, wherein the violet pigment has a quinacridone or dioxazine based structure.

16. The neutral black ink of claim 2,

wherein the carbon black in the neutral black ink is from 1.568 to 2.613 weight percent; the cyan pigment is from 0.317 to 0.529 weight percent and comprises PB15:4 cyan pigment; and the violet pigment is from 0.438 to 0.731 weight

5 percent and comprises violet pigment.

17. The neutral black ink of claim 6, wherein the carbon black in the neutral medium gray ink is from 0.314 to 0.523 weight percent carbon black; the cyan pigment in the neutral medium gray ink is from 0.068 to 0.113

weight percent and comprises PB15:4 cyan pigment; and the violet 10 pigment in the neutral medium gray ink is from 0.101 to 0.169 weight percent and comprises PV23violet pigment.

18. The neutral black ink of claim 9, wherein the carbon black in the neutral dark gray ink is from 0.517 to 0.862 weight percent carbon black; the cyan pigment in the neutral dark gray ink is from 0.105 to 0.174 weight percent and

15 comprises PB15:4 cyan pigment; and the violet pigment in the neutral dark gray ink is from 0.145 to 0.241 weight percent and comprises violet pigment; and wherein the carbon black in the neutral light gray ink is from 0.172 to 0.287 weight percent carbon black; the cyan pigment in the neutral light gray ink is from 0.035 to 0.058 weight percent and comprise cyan pigment; and the violet 20 pigment in the neutral light gray ink is from 0.048 to 0.080 weight percent and comprises PV23 violet pigment.

19. An ink set for ink-jet printing, comprising an ink set of a neutral black ink and at least one ink selected from the group consisting of neutral medium gray ink, neutral dark gray ink, neutral light gray ink, cyan ink, magenta ink, yellow 25 ink, light cyan ink, light magenta ink, red ink, green ink, blue ink, violet ink and orange ink;

wherein carbon black (Ki), cyan pigment (Ci) and either violet or magenta pigment (V/Mi) comprise the neutral black ink; and wherein aKi Spectrum + bCi Spectrum + cV/Mi Spectrum = Neutral i Spectrum of absorptivity where a, b and 30 c are weight percentages of Ki, Ci and V/Mi in Neutral i and a + b+ c = 100%, and where the total absorptivity of Ki, Ci, V/Mi, and Neutral i Spectra is expressed at between 350 and 750 nm wavelength and the Neutral i Spectrum approximates a horizontal line on a graph having a horizontal axis showing wavelength and a vertical axis showing absorptivity.

20. An ink set for ink-jet printing, comprising an ink set of a neutral black ink and at least one ink selected from the group consisting of neutral medium gray ink, neutral dark gray ink, neutral light gray ink, cyan ink, magenta ink, yellow ink, light cyan ink, light magenta ink, red ink, green ink, blue ink, violet ink and orange ink;
- 5 wherein the absorbance ratio of carbon black: cyan pigment: violet pigment for neutral black ink is 0.18:0.05:0.08 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet
- 10 and at 500nm for carbon black and each ratio value ranging +/- 25%; and wherein the carbon black, cyan pigment and violet pigment are associated with a polymer or polymers which render the carbon black, cyan pigment and violet pigment dispersible in aqueous solution.
- 15 21. The ink set of claim 20 wherein the wavelength of the peak maxima for the cyan of the neutral black ink is 610 to 620 nm.
22. The ink set of claim 20 wherein the wavelength of the peak maxima for the violet of the neutral black ink is 530 to 540 nm.
- 20 23. The ink set of claim 20, wherein the polymer or polymers comprise acrylates.
24. The ink set of claim 20, wherein when the ink-set comprises neutral medium gray ink, the absorbance ratio of carbon black: cyan pigment: violet pigment for the neutral medium gray ink is 0.04:0.01:0.02 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25%.
- 25 25. The ink set of claim 24 wherein the wavelength of the peak maxima for the cyan of the neutral medium gray ink is 610 to 620 nm.
26. The ink set of claim 24 wherein the wavelength of the peak maxima for the violet of the neutral medium gray ink is 530 to 540 nm.
- 30 27. The ink set of claim 20, wherein when the ink-set comprises neutral dark gray ink and neutral light gray ink, the absorbance ratio of carbon black: cyan pigment: violet pigment for the neutral dark gray ink is 0.06:0.02:0.03 with

values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25 %;

and the absorbance ratio of carbon black: cyan pigment: violet pigment for the neutral light gray ink is 0.02:0.01:0.01 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25%.

28. The ink set of claim 27 wherein the wavelength of the peak maxima for the cyan of the neutral dark gray ink is 610 to 620 nm.

10 29. The ink set of claim 27 wherein the wavelength of the peak maxima for the violet of the neutral dark gray ink is 530 to 540 nm.

30. The ink set of claim 27 wherein the wavelength of the peak maxima for the cyan of the neutral light gray ink is 610 to 620 nm.

31. The ink set of claim 27 wherein the wavelength of the peak maxima for the violet of the neutral light gray ink is 530 to 540 nm.

32. The ink set of claim 20, wherein the ink set is a three-ink ink set comprising neutral black ink, neutral dark gray ink, and neutral light gray ink.

33. The ink set of claim 20, wherein the ink set is a six-ink ink set comprising neutral black ink, neutral gray ink for use with neutral light gray ink, neutral light gray ink, cyan ink, magenta ink, and yellow ink.

34. The ink set of claim 20, wherein the ink set is an eight-ink ink set comprising neutral black ink, neutral gray ink for use with neutral light gray ink, neutral light gray ink, cyan ink, magenta ink, yellow ink, light cyan ink and light magenta ink.

35. The ink set of claim 20, wherein the ink set is a twelve-ink ink set comprising neutral black ink, neutral medium gray ink, cyan ink, magenta ink, yellow ink, light cyan ink, light magenta ink, red ink, green ink, blue ink, violet ink, and orange ink.

30 36. The ink set of claim 20, wherein the violet pigment is selected from the group consisting of PV19, PV42, PV23, PV3, PV19, PV23, PV32, PV36, and PV38.

37. The ink set of claim 20, wherein the violet pigment has a quinacridone or dioxazine based structure.

38. The ink set of claim 20, wherein the carbon black in the neutral black ink is from 1.568 to 2.613 weight percent; the cyan pigment in the neutral black ink is from 0.317 to 0.529 weight percent and comprises PB15:4 cyan pigment; and the violet pigment in the neutral black ink is from 0.438 to 0.731 weight percent
5 and comprises PV23 violet pigment.

39. The ink set of claim 24, wherein the carbon black in the neutral medium gray ink is from 0.314 to 0.523 weight percent carbon black; the cyan pigment is from 0.068 to 0.113 weight percent and comprises PB15:4 cyan pigment; and the violet ink comprises from 0.101 to 0.169 weight percent and comprises
10 PV23 violet pigment.

40. The ink set of claim 27, wherein the carbon black in the neutral dark gray ink is from 0.517 to 0.862 weight percent; the cyan pigment in the neutral dark gray ink is from 0.105 to 0.174 weight percent and comprises PB15:4 cyan pigment; and the violet pigment in the neutral dark gray ink is from 0.145 to
15 0.241 weight percent and comprises PV23 violet pigment; and wherein the carbon black in the neutral light gray ink is from 0.172 to 0.287 weight percent; the cyan pigment in the neutral light gray ink is from 0.035 to 0.058 weight percent and comprises PB15:4 cyan pigment; and the violet pigment in the neutral light gray ink is from 0.048 to 0.080 weight percent and comprises PV23
20 violet pigment.

41. A method of printing gray, black and neutral areas with decreased browning and metamerism in ink-jet printing, comprising:
printing on a medium with an ink set of neutral black and at least one ink selected from the group consisting of neutral medium gray ink, neutral dark gray
25 ink, neutral light gray ink, cyan ink, magenta ink, yellow ink, light cyan ink, light magenta ink, red ink, green ink, blue ink, violet ink and orange ink;

wherein carbon black (Ki), cyan pigment (Ci) and either violet or magenta pigment (V/Mi) comprise the neutral black ink; and wherein aKi Spectrum + bCi Spectrum + cV/Mi Spectrum = Neutral i Spectrum of absorptivity where a, b and c are weight percentages of Ki, Ci and V/Mi in Neutral i and $a + b + c = 100\%$, and where the total absorptivity of Ki, Ci, V/Mi, and Neutral i Spectra is expressed at between 350 and 750 nm wavelength and the Neutral i Spectrum
30

approximates a horizontal line on a graph having a horizontal axis showing wavelength and a vertical axis showing absorptivity.

42. A method of printing gray, black and neutral areas with decreased
5 browning and metamericism in ink-jet printing comprising:

printing on a medium with an ink set of neutral black and at least one ink selected from the group consisting of neutral medium gray ink, neutral dark gray ink, neutral light gray ink, cyan ink, magenta ink, yellow ink, light cyan ink, light magenta ink, red ink, green ink, blue ink, violet ink and orange ink;

- 10 wherein the absorbance ratio of carbon black: cyan pigment: violet pigment for the neutral black ink is 0.18:0.05:0.08 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25%; and wherein the carbon black, cyan pigment and violet pigment are associated
15 with a polymer or polymers which render the carbon black, cyan pigment and violet pigment dispersible in aqueous solution.

43. The method of claim 42 wherein the wavelength of the peak maxima for the cyan of the neutral black ink is 610 to 620 nm.

44. The method of claim 42 wherein the wavelength of the peak maxima for the
20 violet of the neutral black ink is 530 to 540 nm.

45. The method of claim 42, wherein the polymer or polymers are acrylates.

46. The method of claim 42, wherein when the ink-set comprises neutral medium gray ink, the absorbance ratio of carbon black: cyan pigment: violet
25 pigment for the neutral medium gray ink is 0.04:0.01:0.02 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black wavelength and each ratio value ranging +/- 25 %.

47. The method of claim 46 wherein the wavelength of the peak maxima for the
30 cyan of the neutral medium gray ink is 610 to 620 nm.

48. The method of claim 46 wherein the wavelength of the peak maxima for the violet of the neutral medium gray ink is 530 to 540 nm.

49. The method of claim 42, wherein when the ink-set comprises neutral dark gray ink and neutral light gray ink, the absorbance ratio of carbon black: cyan pigment: violet pigment for the neutral dark gray ink is 0.06:0.02:0.03 with values being measured at 1/5K dilution, at the peak maxima between 400nm and 700nm wavelength for cyan and violet and at 500nm for carbon black and each ratio value ranging +/- 25%; and the absorbance ratio of carbon black: cyan pigment: violet pigment for the neutral light gray ink is 0.02:0.01:0.01 with values being measured at 1/5K dilution, 400-700 wavelength and each ratio value ranging +/- 25%.
- 5 50. The method of claim 49 wherein the wavelength of the peak maxima for the cyan of the neutral dark gray ink is 610 to 620 nm.
- 10 51. The method of claim 49 wherein the wavelength of the peak maxima for the violet of the neutral dark gray ink is 530 to 540 nm.
- 15 52. The method of claim 49 wherein the wavelength of the peak maxima for the cyan of the neutral light gray ink is 610 to 620 nm.
53. The method of claim 49 wherein the wavelength of the peak maxima for the violet of the neutral light gray ink is 530 to 540 nm.
- 20 54. The method of claim 42, wherein the ink set is a three-ink ink set comprising neutral black ink, neutral dark gray ink, and neutral light gray ink.
55. The method of claim 42, wherein the ink set is a six-ink ink set comprising neutral black ink, neutral dark gray ink, neutral light gray ink, cyan ink, magenta ink, and yellow ink.
- 25 56. The method of claim 42, wherein the ink set is an eight-ink ink set comprising neutral black ink, neutral dark gray ink, neutral light gray ink, cyan ink, magenta ink, yellow ink, light cyan ink and light magenta ink.
57. The method of claim 42, wherein the ink set is a twelve-ink ink set comprising neutral black ink, neutral medium gray ink, cyan ink, magenta ink, yellow ink, light cyan ink, light magenta ink, red ink, green ink, blue ink, violet ink, and orange ink.
- 30 58. The method of claim 42, wherein the violet pigment is selected from the group consisting of PV19, PV42, PV23, PV3, PV19, PV23, PV32, PV36, and PV38.

59. The method of claim 42, wherein the violet has a quinacridone or dioxazine based structure.

60. The method of claim 42, wherein the carbon black in the neutral black ink is from 1.568 to 2.613 weight percent; the cyan pigment in the neutral black ink

5 is from 0.317 to 0.529 weight percent and comprises PB15:4 cyan pigment; and violet pigment in the neutral black ink is from 0.438 to 0.731 weight percent and comprises PV23 violet pigment.

61. The method of claim 46, wherein the carbon black in the neutral medium gray ink is from 0.314 to 0.523 weight percent; the cyan pigment is from 0.068

10 to 0.113 weight percent and comprises PB15:4 cyan pigment; and the violet pigment is from 0.101 to 0.169 weight percent and comprises PV23 violet pigment.

62. The method of claim 49, wherein the carbon black in the neutral dark gray ink is from 0.517 to 0.862 weight percent; the cyan pigment in the neutral

15 dark gray ink is from 0.105 to 0.174 weight percent and comprises PB15:4 cyan pigment; and the violet pigment in the neutral dark gray ink is from 0.145 to 0.241 weight percent violet pigment; and wherein the carbon black in the neutral light gray ink is from 0.172 to 0.287 weight percent; the cyan pigment in the neutral light gray ink is from 0.035 to 0.058 weight percent and comprises

20 PB15:4 cyan pigment; and the violet pigment in the neutral light gray ink is from 0.048 to 0.080 weight percent and comprises PV23 violet pigment.